PATENT SPECIFICATION 908,183

DRAWINGS ATTACHED.

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COMPLETE SPECIFICATION.

Improvements in or relating to Valves for Hydraulic Control Systems.

We, HAYES ENGINEERS (LEEDS) LIMITED, of Gelderd Road, Leeds 12, in the County of York, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a valve for controlling the flow of liquid in hydraulic systems and particularly to the type of self-centring valve unit which is normally centralised by spring pressure.

It is known to use a ported valve plunger with centralising end springs and stop elements which ensure positive centralisation in a ported housing. With such an arrangement hydraulic fluid impinges on the ends of the plunger and when the fluid pressure varies at the ends the plunger is automatically displaced to the left or right from its central position.

The main object of this invention is to provide a modified form of valve of the above type.

Accordingly there is provided a valve unit for controlling the flow of liquid in a hydraulic system, said unit including a ported housing containing a valve plunger centralised from each end by movable stop elements urged to their stop positions by springs, characterised in that each end of the plunger in combination with the unit ported housing provides an annular orifice for the equal flow of hydraulic fluid through each annular orifice when the plunger is centralised by its spring and stop elements, each of said orifices becoming progressively greater should the fluid flow increase at the end of the unit, whereby as the flow is increased at either end of the valve unit the valve plunger will tend to move axially to accommodate this flow and the opposing spring will resist and thus create a hydraulic pressure which moves the valve plunger axially against such spring pressure proportionately to said flow until such flow decreases and is overcome by the resistant spring pressure.

The valve plunger may have identical ends each comprising an axial cylindrical stem with a short tapered-off end normally just entering an axial fluid inlet passage in which the cylindrical stem is a neat working fit, the annular edge from which said end tapers off being normally so positioned adjacent an edge at the outlet from said passage as to allow a predetermined flow of fluid through an annular orifice which will progressively increase due to the tapered ends as the plunger is caused to recede by increased hydraulic flow and thus allow a greater proportional fluid flow.

The aforesaid valve unit can be arranged in an hydraulic system controlled by a hydraulic metering valve, say a tracer valve, for fluid to flow through a free exhaust pipe past the ends of the centralised valve plunger, and with a pressurised hydraulic system connected through the unit under the control of the ported plunger to a hydraulic motor for operative purposes.

The invention will now be more particularly described with reference to the accompanying drawings in which:—

Fig. 1 is a longitudinal sectional elevation of one form of the improved valve unit;

Fig. 2 is a diagrammatic view showing the valve unit inserted in a hydraulic control system;

[*Price 4s. 6d.*]

Fig. 3 is a longitudinal sectional elevation of a modified valve unit; and

Fig. 4 is a diagrammatic view showing the modified unit inserted into a hydraulic control system.

In the particular embodiment of this invention shown in Figs. 1 and 2, a valve unit comprises a cylindrical or other hollow housing 1 which is sectionally built, i.e. comprising a central barrel with two end parts 2, 2 all secured together. Within the hollow housing is located a ported liner sleeve 3 with its ports 4, 5 and 6 in register respectively with ports 7, 8 and 9 in the housing to which the usual hydraulic connections can be made for the unit to control a hydraulic operating system. As shown there is one inlet port 7 for pressure feed and two other ports 8, 8 so that pressurised liquid can pass out through one port and return by the other of the pipes 10, 11 connected to the cylinder 12 of piston 13, or the action be reversed according to the controlled movements of a ported valve plunger 14 which is located in the said liner sleeve 3.

The valve plunger 14 may be a simple solid cylindrical member and is furnished with two annular ports 15 in its periphery to co-operate with the ports in the liner sleeve.

To normally centralise the valve plunger 14 with the housing a pair of identical end movable stop elements 16 are provided and conveniently each comprises a collar furnished with an external peripheral flange 17 to butt against the end of the liner sleeve 3 which thus forms a fixed stop face for the movable element. These movable stop elements are held against the fixed stop faces by coiled springs 18, each spring having one end located on the collar 16 and bearing against the outer face of the said flange 17 and the other end of the spring bearing against the base of a recess 19 formed in the end part 2 of the valve housing. These collars 16 can be precision-ground so that a predetermined accurate distance is provided between the inner stop face of the aforesaid flange 17 and the inner end of the collar which butts against the end of the valve plunger 14. Thus the valve plunger can be readily and accurately centralised to fine limits within the valve unit housing irrespective of any variations between the springs 18.

An axial hole 20 is formed in each end of the valve housing, its outer end is internally screw-threaded, for connection to be made with the pipes 21, 22 of a hydraulic plunger control system. Thus pressurised liquid can be admitted to both ends of the valve unit and be varied by a metering valve, e.g. tracing valve 23 having pressure feed and exhaust pipes 24, 25 connected thereto, to displace the valve plunger 14 from its normal central position for controlling the flow of liquid in the hydraulic operating system into which the valve unit is inserted.

In this construction the aforesaid axial hole 20, at each end of the valve housing 1, is continued in the form of a liquid inlet passage through an integral sleeve 26 which projects into the aforesaid recess in which the spring is mounted. This sleeve 26 projects a predetermined distance and its end 27, which may be faced, forms a fixed limit stop for the outward axial movement of the adjacent stop collar 16. Moreover, the internal edge of this fixed stop face 27 combines with a tapered-off end 28 of the plunger stem to form, with the plunger centralised, a fine annular orifice 29 for hydraulic liquid entering the housing to flow through into the recess 19 from which it passed out of the housing through an exhaust port 30 to which an exhaust pipe 31 is connected and forming part of the hydraulic control system. The said tapered-off stem end 28 is only short and the angle of taper will be predetermined to suit requirements for the degree of flow and required movement of the ported plunger 14.

In the above manner it will be realised that with the valve unit in operation the ported plunger 14 will be normally centralised by the stop elements 16 and spring loading 18 and in this position there will be a fine hydraulic metering flow through each end of the unit housing without effect on the plunger 14. Operating of the control valve 23 varies the hydraulic flow to increase it at one end and this will act on the plunger stem ends 28 and due to the resistance of the opposite spring loading hydraulic pressure will be created on the said valve stem end and cause the plunger to recede, thus opening the orifice 29 proportionally and allow a proportionally greater flow of hydraulic fluid through to exhaust. Such displacement of the ported valve plunger 14 will either open the ports for a pressure feed through the unit, or increase such feed, depending on the porting of the plunger, and thus the hydraulic motor 12, 13 in the operating system will be operated accordingly. When the control system is varied to allow equalised flow through the ends of the housing 1 the valve plunger 14 will automatically be again centralised by its spring loading 18 and stop elements 16.

The above arrangement discloses a suitable control system for a machnie tool such as a milling machine with the hydraulic motor 12, 13 forming the operating means for a traversing movement of a worktable.

In some cases the system may be modified to include a control valve in the system

between the unit and hydraulic motor. A suitable arrangement is shown in Figs. 3 and 4 wherein a change-over valve 32 of known pattern is connected to the pipes 10*a*, 11*a* with a pipe 33 leading from the valve unit and a pipe 34 to exhaust. The valve 32 may be operated manually or tripped automatically by means on the worktable. In this arrangement the valve unit (Fig. 3) is modified by the provision of two pressure feed inlets 7*a* in the housing 1 communicating with inlet ports 4*a* in the sleeve 3, a feed port 6*a* in the sleeve in register with the feed outlet 8*a* in the housing 1, and the annular ports 15 in the plunger 14 dimensioned to suit.

The tracing valve 23*a* in this instance is of the double type with a second valve member 35 controlling a second hyraulic motor, cylinder 36 and piston 37 say for controlling the vertical traverse of a worktable. It will be understood a single valve tracing unit 23 may be used.

WHAT WE CLAIM IS:—

1. A valve unit for controlling the flow of liquid in a hydraulic system, said unit including a ported housing containing a valve plunger centralised from each end by movable stop elements urged to their stop positions by springs, characterised in that each end of the plunger in combination with the unit ported housing provides an annular orifice for the equal flow of hydraulic fluid through each annular orifice when the plunger is centralised by its spring and stop elements, each of said orifices becoming progressively greater should the fluid flow increase at the end of the unit, whereby as the flow is increased at either end of the valve unit the valve plunger will tend to move axially to accommodate this flow and the opposing spring will resist and thus create a hydraulic pressure which moves the valve plunger axially against such spring pressure proportionately to said flow until such flow decreases and is overcome by the resistant spring pressure.

2. Valve unit according to Claim 1, wherein the valve plunger has identical ends each comprising an axial cylindrical stem with a short tapered-off end normally just entering an axial fluid inlet passage in which the cylindrical stem is a neat working fit, the annular edge from which said end tapers off being normally so positioned adjacent an edge at the outlet from said passage as to allow a predetermined flow of fluid through an annular orifice which will progressively increase due to the tapered ends as the plunger is caused to recede by increased hydraulic flow and thus allow a greater proportional fluid flow.

3. Valve unit according to Claim 1 or 2, wherein the valve plunger is centralised by a pair of through ported or sleeve-like stop elements each normally bearing against one end of the valve plunger and having external projecting stop means normally bearing against fixed stop means of the unit housing but movable with the plunger against the spring action.

4. Valve unit according to Claim 1, 2 or 3, wherein the ported plunger has identical end stems projecting through externally flanged stop collars which are spring-loaded and serve to centralise the plunger at rest, said stems having their ends adapted to co-act with fixed peripheral edges or faces of fluid inlets and movable in relation thereto under fluid pressure to permit a variation in flow in excess of the flow of fluid which is normally continuously exhausted from the valve unit when the valve plunger is in its centralised position.

5. Valve unit according to any of the preceding claims, wherein the ends of the ported plunger co-act with two axially disposed fluid inlet passages in the ends of the unit housing, said passages extending through fixed sleeves projecting into recesses in the housing, and fluid exhaust ports leading from said recesses.

6. Valve unit according to any of the preceding claims arranged in an hydraulic system controlled by a hydraulic metering valve, say a tracer valve, for fluid to flow through a free exhaust pipe past the ends of the centralised valve plunger, and with a pressurised hydraulic system connected through the unit under the control of the ported plunger to a hydraulic motor for operative purposes.

7. Valve unit in a hydraulic system according to Claim 6, wherein the ported plunger in the valve unit controls the flow of pressurised fluid to the ends of a piston and cylinder hydraulic motor.

8. Valve unit in a hydraulic system according to Claim 6, wherein the flow of pressurised fluid from the valve unit to the ends of a piston and cylinder hydraulic motor is controlled by a manual or automatic change-over valve.

9. Valve unit including a normally centralised valve plunger substantially as described with reference to Figs. 1 or 3 of the accompanying drawings.

10. Valve unit in a hydraulic system with a normally centralised valve plunger in the unit substantially as described with reference to Fig. 2 or 4 of the accompanying drawings.

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PROVISIONAL SPECIFICATION.

Improvements in or relating to Valves for Hydraulic Control Systems.

We, HAYES ENGINEERS (LEEDS) LIMITED, of Gelderd Road, Leeds 12, in the County of York, a British Company, do hereby declare this invention to be described in the following statement:—

This invention relates to valve controlled hydraulic systems and particularly to the type of self-centring valve unit which is normally centralised by spring pressure and disclosed in our prior Patent Application No. 1846/58 filed 20th September, 1958.

In the Provisional Specification accompanying our above-mentioned prior Patent Application we disclosed a ported valve plunger with centralising end springs and stop elements which ensure positive centralisation in a ported housing. In such Specification we refer to hydraulic fluid impinging on the ends of the plunger and when the fluid pressure varies at the ends the plunger will automatically be displaced to the left or right from its central position.

The main object of this invention is to provide a modified form of valve of the above type.

Accordingly there is provided a valve unit for controlling the flow of liquid in a hydraulic system, characterised in that identical provision is made at each end of the unit ported housing for a normally balanced metering flow of hydraulic fluid through an annular orifice when the ported plunger is centralised by its springs and stop elements, each of said orifices being such as to become progressively greater in response to increased fluid flow at that end of the unit, whereby as the flow is increased at either predetermined end of the valve unit the opposing spring will momentarily resist and thus create a hydraulic pressure which forces the valve proportionately open against such spring pressure according to said flow until such flow decreases and is overcome by the resistant spring pressure.

The valve plunger may have identical ends each comprising an axial cylindrical stem with a short tapered-off end normally just entering an axial fluid inlet passage in which the cylindrical stem is a neat working fit, the annular edge from which said end tapers off being normally so positioned adjacent an edge at the outlet from said passage as to allow a fine metering flow of fluid through an annular orifice which will progressively increase due to the tapered ends as the plunger is caused to recede by increased hydraulic flow and thus allow a greater proportional fluid flow.

The aforesaid valve unit can be arranged in an hydraulic system controlled by a hydraulic metering valve, say a tracer valve, for fluid to flow through a free exhaust pipe past the ends of the centralised valve plunger, and with a pressurised hydraulic system connected through the unit under the control of the ported plunger to a hydraulic motor for operative purposes.

In a particular embodiment of this invention a valve unit comprises a cylindrical or other hollow housing which may be sectionally built, i.e., it may comprise a central barrel with two end parts all secured together. Within the hollow housing is located a ported liner sleeve with the ports in register with ports in the housing to which the usual hydraulic connections can be made for the unit to control a hydraulic operating system. For example, there can be at least one inlet port for pressure feed and at least two other ports so that pressurised liquid can pass out through one port and return by the other or the action be reversed according to the controlled movements of a ported valve plunger which is located in the said liner sleeve.

The valve plunger may be a simple solid cylindrical member furnished with a required number, say two, annular ports in its periphery to co-operate with the ports in the liner sleeve.

To normally centralise the valve plunger within the housing a pair of end movable stop elements are provided and conveniently each may comprise a collar furnished with an external peripheral flange to butt against the end of the liner sleeve which thus forms a fixed stop face for the movable element. These movable stop elements are held against the fixed stop faces by coiled springs, each spring having one end located on the collar and bearing against the outer face of the said flange and the other end of the spring bearing against the base of a recess formed in the end part of the valve housing. These collars can be precision-ground so that a predetermined accurate distance is provided between the inner stop face of the aforesaid flange and the inner end of the collar which butts against the end of the valve plunger. Thus the valve plunger can be readily and accurately centralised to fine limits within the valve unit housing irrespective of any variations between the springs.

An axial hole is formed in each end of the valve housing, it can be internally screw-threaded, for connection to be made with the pipes of a hydraulic plunger con-

trol system so that pressurised liquid can be admitted to both ends of the valve unit and be carried by a metering valve to displace the valve plunger from its normal central position for controlling the flow of liquid in the hydraulic operating system into which the valve is inserted.

In this construction the aforesaid axial hole, at each end of the valve housing, is continued in the form of a fluid inlet passage through an integral sleeve which projects into the aforesaid recess in which the spring is mounted. This sleeve projects a predetermined distance and its end, which may be faced, forms a fixed limit stop for the outward axial movement of the adjacent stop collar. Moreover, the internal edge of this fixed stop face combines with a tapered-off end of the plunger stem to form, with the plunger centralised, a fine annular metering orifice for hydraulic liquid entering the housing to flow through into the recess from which it passes out of the housing through an exhaust port to which an exhaust pipe is connected and forming part of the hydraulic control system. The said tapered-off stem is only short and the angle of taper will be predetermined to suit requirements for the degree of flow and required movement of the ported plunger.

In the above manner it will be realised that with the unit in operation the ported plunger will be normally centralised by the stop elements and spring loading and in this position there will be a fine hydraulic metering flow through each end of the unit housing without effect on the plunger. Operation of the control metering valve varies the hydraulic flow to increase it at one end and this will act on the plunger stem and due to the resistance of the opposite spring loading hydraulic pressure will be created on the said valve stem and cause the plunger to recede, thus opening the metering orifice proportionally and allow a proportionally greater flow of hydraulic fluid through to exhaust. Such displacement of the ported valve plunger will either open the ports for a pressure fed through the unit, or to increase such feed, depending on the porting of the plunger, and thus a hydraulic motor in the operating system will be operated accordingly. When the control system is varied to allow equalised flow through the ends of the housing the valve plunger will automatically be again centralised by its spring loading and stop elements.

It will be understood that stop elements may be modified as indicated in the prior Patent Application for achieving accurate centralisation of the plunger

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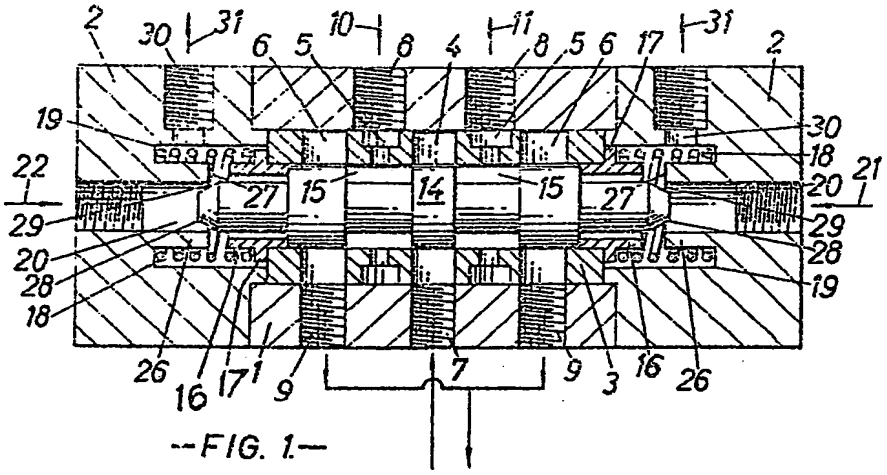
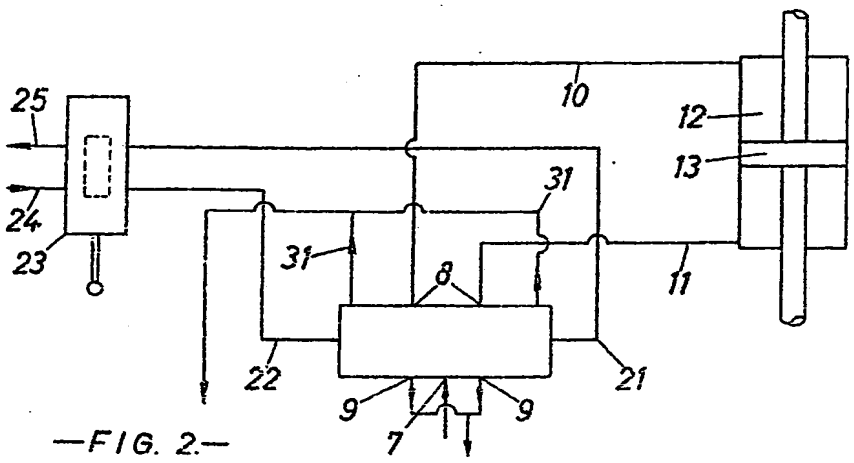


--FIG. 1.—



—FIG. 2.—

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2 SHEETS
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SHEETS 1 & 2

21
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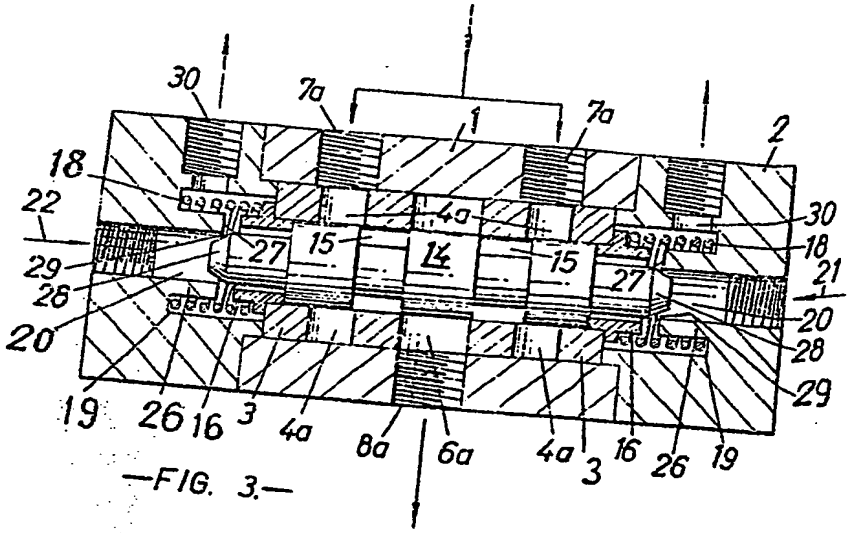
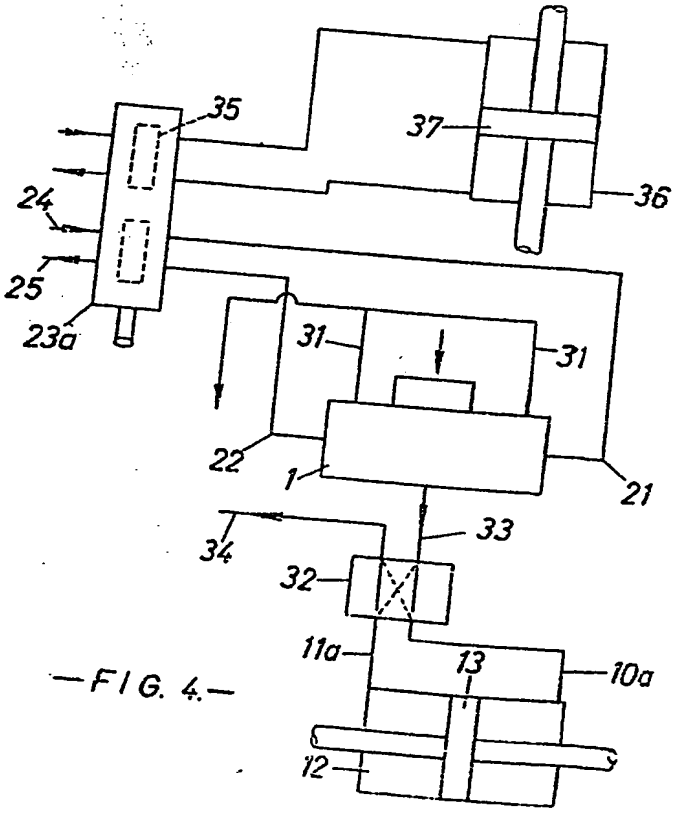


—FIG. 3.—



—FIG. 4.—

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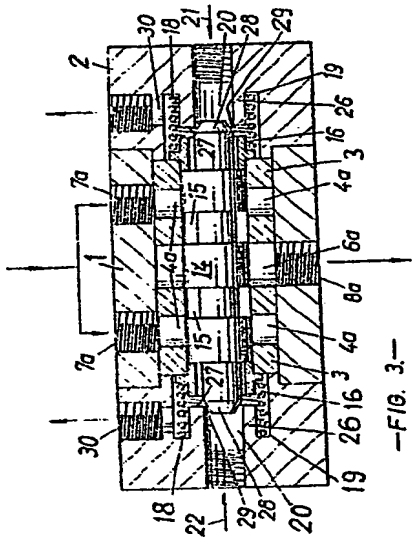
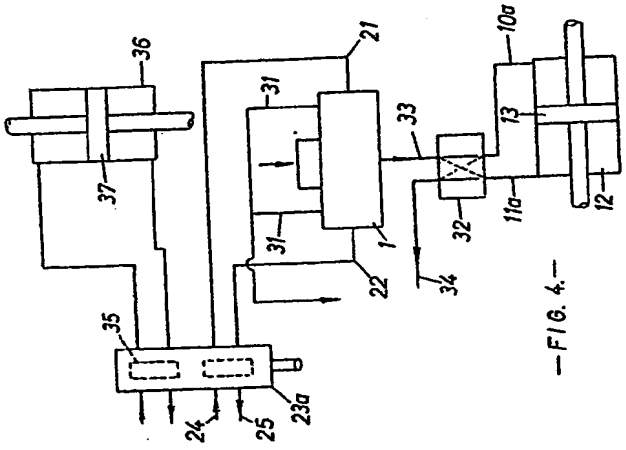
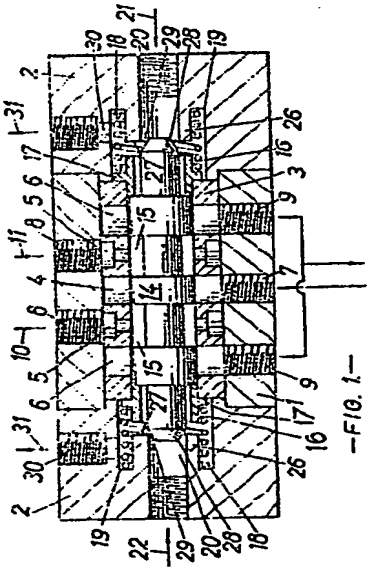
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2



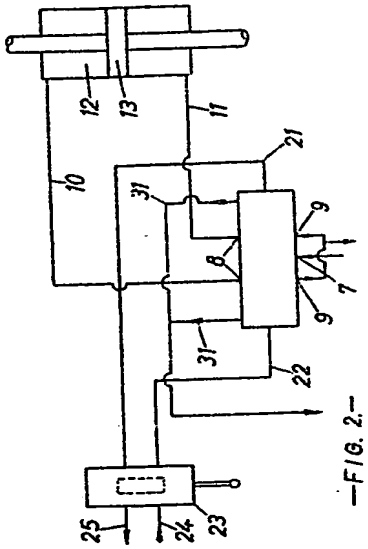
—FIG. 3.—



—FIG. 4.—



—FIG. 1.—



—FIG. 2.—